

What is claimed is:

1 1. An ionomer composite composition having
2 improved physical properties, the composite consisting
3 essentially of:

4 a glass material containing at least one of
5 divalent cations and multivalent cations; and

6 at least one copolymer, comprising:

7 at least one hydrophilic monomer
8 containing acid functional groups adapted to react with
9 the at least one of divalent cations and multivalent
10 cations to form ionic crosslinks among polymer chains,
11 the hydrophilic monomer present in an amount sufficient
12 to impart a desired degree of aqueous solubility to the
13 copolymer; and

14 at least one hydrophobic monomer present
15 in an amount sufficient to impart a desired degree of
16 structural stability to the composite composition when
17 exposed to an aqueous environment.

1 2. The ionomer composite composition as
2 defined in claim 1 wherein the glass material further
3 contains fluoride, and wherein the composite composition
4 provides substantially continuous fluoride release.

1 3. The ionomer composite composition as
2 defined in claim 1 wherein the glass material is selected
3 from the group consisting of SiO_2 , Al_2O_3 , AlF_3 , CaF_2 ,
4 NaF , Na_3AlF_6 , AlPO_4 , and mixtures thereof.

1 4. The ionomer composite composition as
2 defined in claim 1 wherein a weight ratio of glass
3 material to copolymer ranges between about 10:90 and
4 about 90:10.

1 5. The ionomer composite composition as
2 defined in claim 4 wherein the weight ratio of glass
3 material to copolymer ranges between about 40:60 and
4 about 85:15.

1 6. The ionomer composite composition as
2 defined in claim 1 wherein the at least one hydrophilic
3 monomer is a monomer containing unsaturated carboxylic
4 acid.

1 7. The ionomer composite composition as
2 defined in claim 6 wherein the unsaturated carboxylic
3 acid is selected from the group consisting of: acrylic
4 acid, methacrylic acid, 4-vinylbenzoic acid, crotonic
5 acid, oleic acid, elaidic acid, itaconic acid, maleic
6 acid, fumaric acid, acetylenedicarboxylic acid,
7 tricarbollylic acid, sorbic acid, linoleic acid,
8 linolenic acid, eicosapentenoic acid, anhydrides of the
9 acids, derivatives of the unsaturated carboxylic acids,
10 and mixtures thereof.

1 8. The ionomer composite composition as
2 defined in claim 7 wherein the hydrophilic monomer is
3 selected from the group consisting of organic acids
4 having at least one of sulfonic acid and phosphonic acid
5 replacement of the carboxyl group of the unsaturated
6 carboxylic acids, derivatives of the organic acids, and
7 mixtures thereof.

1 9. The ionomer composite composition as
2 defined in claim 1 wherein the at least one hydrophobic
3 monomer is unsaturated.

1 10. The ionomer composite composition as
2 defined in claim 9 wherein the at least one hydrophobic
3 monomer is selected from the group consisting of
4 acrylates, methacrylates, ethylenes, propylenes, tetra-
5 fluoroethylene, styrenes, vinyl chloride, vinylidene
6 chloride, vinyl acetate, acrylonitrile, 2,2-bis[4-(2-
7 hydroxy-3-methacryloyloxy-propyloxy)-phenyl] propane
8 (Bis-GMA), ethyleneglycol dimethacrylate (EGDMA), tri-
9 ethyleneglycol dimethacrylate (TEGDMA), bis(2-methacryly-
10 oxyethyl) ester of isophthalic acid (MEI), bis(2-meth-

11 acrylyoxyethyl) ester of terephthalic acid (MET), bis(2-
12 methacrylyoxyethyl) ester of phthalic acid (MEP), 2,2-
13 bis(4-methacrylyoxy phenyl) propane (BisMA), 2,2-bis[4-
14 (2-methacrylyloxyethoxy) phenyl] propane (BisEMA), 2,2-
15 bis[4-(3-methacrylyloxy-propoxy) phenyl] propane
16 (BisPMA), hexafluoro-1,5-pentanediol dimethacrylate
17 (HFPDMA), bis-(2-methacrylyloxyethoxy-hexafluoro-2-
18 propyl) benzene [Bis(MEHFP) ϕ], 1,6-bis(methacrylyloxy-2-
19 ethoxycarbonylamino)-2,4,4-tri-methylhexan (UEDMA), spiro
20 orthocarbonates, derivatives of the hydrophobic monomers,
21 and mixtures thereof.

1 11. The ionomer composite composition as
2 defined in claim 1 wherein a ratio of the hydrophilic
3 monomer to the hydrophobic monomer is between about 1:99
4 and about 99:1.

1 12. The ionomer composite composition as
2 defined in claim 1 wherein the at least one copolymer is
3 selected from the group consisting of poly(methyl
4 methacrylate-methacrylic acid), poly(methyl acrylate-
5 acrylic acid), poly(methyl methacrylate-acrylic acid),
6 poly(ethyl acrylate-acrylic acid), poly(ethyl
7 methacrylate-methacrylic acid), poly(butyl acrylate-
8 acrylic acid), poly(ethylene-acrylic acid),
9 poly(ethylene-methacrylic acid), poly(acrylonitrile-
10 maleic anhydride), poly(butadiene-acrylonitrile-acrylic
11 acid), poly(butadiene-maleic acid), poly(butadiene-maleic
12 anhydride), poly(acrylamide-acrylic acid), poly(2-
13 hydroxyethyl methacrylate-methacrylic acid),
14 poly(propylene-acrylic acid), poly(propylene-ethylene-
15 acrylic acid), poly(vinyl chloride-vinyl acetate-maleic
16 acid), and mixtures thereof.

1 13. The ionomer composite composition as
2 defined in claim 1 wherein the composite further includes
3 as a minor constituent a polymer selected from the group

4 consisting of PMMA, polycarbonates, polyethylenes,
5 polyamides, PEEK polymers, epoxies, and mixtures thereof.

1 14. The ionomer composite composition as
2 defined in claim 2 wherein the composite further includes
3 a minor constituent selected from the group consisting of
4 pigments, surfactants, adhesion enhancers, fluoride
5 releasing enhancers, bioactive agents, and mixtures
6 thereof.

1 15. The ionomer composite composition as
2 defined in claim 2 wherein the glass material consists of
3 25.10 wt% SiO₂, 37.45 wt% Al₂O₃, and 37.45 wt% CaF₂.

1 16. The ionomer composite composition as
2 defined in claim 1 wherein the at least one copolymer is
3 poly(methyl methacrylate-co-methacrylic acid) (PMMA-MAA).

1 17. The ionomer composite composition as
2 defined in claim 16 wherein the ratio of PMMA to MAA is
3 80:20.

1 18. An ionomer composite composition having
2 improved physical properties and useful for dental
3 applications, the composite consisting essentially of:
4 a glass material containing at least one of
5 divalent cations and multivalent cations; and
6 at least one copolymer, comprising:
7 at least one hydrophilic monomer
8 containing acid functional groups adapted to react with
9 the at least one of divalent cations and multivalent
10 cations to form ionic crosslinks among polymer chains,
11 the hydrophilic monomer present in an amount sufficient
12 to impart a desired degree of aqueous solubility to the
13 copolymer; and
14 at least one hydrophobic monomer present
15 in an amount sufficient to impart a desired degree of

16 structural stability to the composite composition when
17 exposed to an aqueous environment;
18 wherein the composite composition is adaptable
19 for use in dental applications ranging from those
20 requiring water soluble compositions, to intermediary
21 materials, to those requiring water insoluble
22 compositions.

1 19. The ionomer composite composition as
2 defined in claim 18 wherein the glass material further
3 contains fluoride, and wherein the composite composition
4 provides substantially continuous fluoride release.

1 20. The ionomer composite composition as
2 defined in claim 19 wherein the glass material is
3 selected from the group consisting of SiO_2 , Al_2O_3 , AlF_3 ,
4 CaF_2 , NaF , Na_3AlF_6 , AlPO_4 , and mixtures thereof.

1 21. The ionomer composite composition as
2 defined in claim 20 wherein the weight ratio of glass
3 material to copolymer ranges between about 40:60 and
4 about 85:15.

1 22. The ionomer composite composition as
2 defined in claim 21 wherein the at least one hydrophilic
3 monomer is an unsaturated carboxylic acid selected from
4 the group consisting of: acrylic acid, methacrylic acid,
5 4-vinylbenzoic acid, crotonic acid, oleic acid, elaidic
6 acid, itaconic acid, maleic acid, fumaric acid,
7 acetylenedicarboxylic acid, tricarbollylic acid, sorbic
8 acid, linoleic acid, linolenic acid, eicosapentenoic
9 acid, anhydrides of the acids, derivatives of the
10 unsaturated carboxylic acids, and mixtures thereof.

1 23. The ionomer composite composition as
2 defined in claim 22 wherein the at least one hydrophilic
3 monomer is selected from the group consisting of organic
4 acids having at least one of sulfonic acid and phosphonic

5 acid replacement of the carboxyl group of the unsaturated
6 carboxylic acids, derivatives of the organic acids, and
7 mixtures thereof.

1 24. The ionomer composite composition as
2 defined in claim 22 wherein the at least one hydrophobic
3 monomer is unsaturated and is selected from the group
4 consisting of acrylates, methacrylates, ethylenes,
5 propylenes, tetra-fluoroethylene, styrenes, vinyl
6 chloride, vinylidene chloride, vinyl acetate,
7 acrylonitrile, 2,2-bis[4-(2-hydroxy-3-methacryloyloxy-
8 propyloxy)-phenyl] propane (Bis-GMA), ethyleneglycol
9 dimethacrylate (EGDMA), tri-ethyleneglycol dimethacrylate
10 (TEGDMA), bis(2-methacryly-oxyethyl) ester of isophthalic
11 acid (MEI), bis(2-meth-acrylyoxyethyl) ester of
12 terephthalic acid (MET), bis(2-methacrylyoxyethyl) ester
13 of phthalic acid (MEP), 2,2-bis(4-methacrylyoxy phenyl)
14 propane (BisMA), 2,2-bis[4-(2-methacrylyloxyethoxy)
15 phenyl] propane (BisEMA), 2,2-bis[4-(3-methacrylyloxy-
16 propoxy) phenyl] propane (BisPMA), hexafluoro-1,5-
17 pentanediol dimethacrylate (HFPDMA), bis-(2-
18 methacrylyloxyethoxy-hexafluoro-2-propyl) benzene
19 [Bis(MEHFP) ϕ], 1,6-bis(methacrylyloxy-2-
20 ethoxycarbonylamino)-2,4,4-tri-methylhexan (UEDMA), spiro
21 orthocarbonates, derivatives of the hydrophobic monomers,
22 and mixtures thereof.

1 25. The ionomer composite composition as
2 defined in claim 24 wherein a ratio of the hydrophilic
3 monomer to the hydrophobic monomer is between about 1:99
4 and about 99:1.

1 26. The ionomer composite composition as
2 defined in claim 18 wherein the at least one copolymer is
3 selected from the group consisting of poly(methyl
4 methacrylate-methacrylic acid), poly(methyl acrylate-
5 acrylic acid), poly(methyl methacrylate-acrylic acid),
6 poly(ethyl acrylate-acrylic acid), poly(ethyl

7 methacrylate-methacrylic acid), poly(butyl acrylate-
8 acrylic acid), poly(ethylene-acrylic acid),
9 poly(ethylene-methacrylic acid), poly(acrylonitrile-
10 maleic anhydride), poly(butadiene-acrylonitrile-acrylic
11 acid), poly(butadiene-maleic acid), poly(butadiene-maleic
12 anhydride), poly(acrylamide-acrylic acid), poly(2-
13 hydroxyethyl methacrylate-methacrylic acid),
14 poly(propylene-acrylic acid), poly(propylene-ethylene-
15 acrylic acid), poly(vinyl chloride-vinyl acetate-maleic
16 acid), and mixtures thereof.

1 27. The ionomer composite composition as
2 defined in claim 18 wherein the composite further
3 includes as a minor constituent a polymer selected from
4 the group consisting of PMMA, polycarbonates,
5 polyethylenes, polyamides, PEEK polymers, epoxies, and
6 mixtures thereof.

1 28. The ionomer composite composition as
2 defined in claim 19 wherein the composite further
3 includes a minor constituent selected from the group
4 consisting of pigments, surfactants, adhesion enhancers,
5 fluoride releasing enhancers, bioactive agents, and
6 mixtures thereof.

1 29. The ionomer composite composition as
2 defined in claim 19 wherein the glass material consists
3 of 25.10 wt% SiO_2 , 37.45 wt% Al_2O_3 , and 37.45 wt% CaF_2 .

1 30. The ionomer composite composition as
2 defined in claim 19 wherein the at least one copolymer is
3 poly(methyl methacrylate-co-methacrylic acid) (PMMA-MAA).

1 31. The ionomer composite composition as
2 defined in claim 30 wherein the ratio of PMMA to MAA is
3 80:20.